FIGURE 1

$$R \underset{H}{\underbrace{ \begin{array}{c} O \\ N \\ I \\ H \end{array}}} NH_2$$

hydrazine

semicarbazide

$$R \underset{O}{\overset{H}{\underset{N}{\bigvee}}} NH_{2}$$

$$\begin{array}{c|c} R & S \\ N & N \\ \downarrow & \downarrow \\ H & H \end{array}$$

hydrazide

thiosemicarbazide

thiocarbazide

carbonic acid dihydrazine

hydrazine carboxylate

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FIGURE 2

$$\mathbf{H} + \mathbf{A} \xrightarrow{\text{pH 4.7 or 7.4}} \mathbf{Protem A} \xrightarrow{\mathbf{h}} \mathbf{N} \xrightarrow{\mathbf{h}} \mathbf{N} \xrightarrow{\mathbf{h}} \mathbf{N}$$

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FIGURE 3

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FIGURE 4

3.33

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FIGURE 5

Preparation of 5'-aromatic aldehyde-modified oligonucleotide:

Preparation of 5'-heteroaromatic hydrazine-modified oligonucleotide:

 \mathcal{S}_{γ}

Conjugation of hydrazino-modified oligonucleotide to aldehyde-modified oligonucleotide

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FIGURE 6

phosgene, Et3N, THF

$$OCN$$
 OCN
 OCN

...

t-butyl carbazate, THF

1) HCl/dioxane

$$\begin{array}{c|c}
 & O \\
 & N \\$$

NHS, DCC, THF

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FIGURE 7

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FIGURE 8

 $\mathcal{P}_{\mathcal{F}}$

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FIGURE 9

ONH₂.HCl

ONHBOC